JAPAN

EDICT OF GOVERNMENT

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JIS S 0031 (2004) (English): Guidelines for the elderly and people with disabilities -- Visual signs and displays -- Specification of age-related relative luminance and its use in assessment of light

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The citizens of a nation must honor the laws of the land.

Fukuzawa Yukichi

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Guidelines for the elderly and people with disabilities—Visual signs and displays—Specification of age-related relative luminance and its use in assessment of light

ICS 13.120; 17.180.20; 97.020

Reference number : **JIS S 0031 : 2004 (E)**

Foreword

This translation has been made based on the original Japanese Industrial Standard established by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee according to the proposal of establishing a Japanese Industrial Standard from National Institute of Advanced Industrial Science and Technology (AIST)/National Institute of Technology and Evaluation, Conformity Assessment Center (NITE), with a draft of Industrial Standard based on the provision of Article 12 Clause 1 of the Industrial Standardization Law.

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In the event of any doubts arising as to the contents, the original JIS is to be the final authority.

Contents

Guidelines for the elderly and people with disabilities—Visual signs and displays—Specification of age-related relative luminance and its use in assessment of light

Introduction In spite of the rapid increase in the elderly population in Japan, indistinct visual signs and displays for the elderly are increasing. This Japanese Industrial Standard has been established as guidelines for assessing and designing distinct visual signs and displays required so that especially the elderly may lead a safe and comfortable life. This Standard specifies the method of calculating the age-related relative luminance, when the target of various ages looks at the light source and the object, based on the age-related spectral luminous efficiency, and assessing brightness of the light source and the object.

1 Scope This Standard specifies the method of assessment of the visual efficiency of light and the visibility based on it when the target to be observed of ages from the young to the elderly (hereafter referred to as "the target") looks at the light source and the object using the age-related relative luminance in consideration of ages of the target.

In addition, this Standard applies to the light source and the object of which spectral radiance is known or measurable, which are seen under a bright environment called photopic vision, and does not apply to those which are seen under a dark environment called mesopic vision and scotopopic vision.

Remarks 1 The age-related relative luminance specified in this Standard is used only for comparing with the age-related relative luminance obtained by the age-related spectral luminous efficiency of the same age. Therefore, it can not be used for comparing with the luminance obtained by spectral luminous efficiency for the CIE standard photometric observer or with the age-related relative luminance obtained by the age-related spectral luminous efficiency of the different age.

2 This Standard targets at the healthy people without a visual medical history of the age from teens to seventies. Furthermore, for the target of younger than teens or older than seventies, this Standard may apply by extrapolating the age-related spectral luminous efficiency.

3 As the information on usage of the age-related relative luminance, *Example of calculation of visual contrast using age-related relative luminance* is given in Annex 1 (informative), and *Specification of age-related relative luminance and its use in assessment of light* is given in Annex 2 (informative).

2 Normative references The following standards contain provisions which, through reference in this Standard, constitute provisions of this Standard. The most recent editions of the standards (including amendments) shall be applied.

JIS Z 8113 *Lighting vocabulary*

JIS Z 8724 *Methods of colour measurement—Light-source colour*

3 Definitions For the purposes of this Standard, in addition to the definitions in **JIS Z 8113**, the following definitions shall apply.

a) **spectral luminous efficiency** Ratio of the radiant flux at wavelength λ_m to that at wavelength λ when both radiations produce equally intense luminous sensations (brightness sensations) under specified photometric conditions. λ_m is chosen so that the maximum value of this ratio is equal to 1 (see **JIS Z 8113**).

b) **visual efficiency of light** Relative energy efficiency when visible radiation is incorporated in a visual system and visual sensations are produced.

c) **spectral radiance** Radiance expressed as monochromatic radiation or as spectral distribution.

d) **age-related spectral luminous efficiency** Spectral luminous efficiency defined by age in consideration of the change of spectral luminous efficiency with age.

e) **age-related relative luminance** Quantity obtained by calculating by age based on the age-related spectral luminous efficiency, which is equivalent to luminance.

f) **visual response** Visual sensations produced when visible radiation is incorporated in a visual system.

g) **visual effect** The effect of light on various visual functions generated by visual sensations.

h) **spectral luminous efficiency for the CIE standard photometric observer** The value agreed at International Commission on Illumination (CIE) as standard spectral luminous efficiency of man's eyes. There are two types; spectral luminous efficiency for the CIE standard photometric observer $V(\lambda)$ in photopic vision and spectral luminous efficiency for the CIE standard photometric observer $V'(\lambda)$ in scotopopic vision (see **JIS Z 8113**).

4 Specification of age-related relative luminance The age-related relative luminance shall be calculated according to the formula (1).

$$L_{(a)} = \sum_{400}^{700} L_{e,\lambda} V(\lambda)_{(a)} \Delta\lambda \quad \cdots\cdots (1)$$

where, $L_{(a)}$: age-related relative luminance ($W \cdot m^{-2} \cdot sr^{-1}$)

$L_{e,\lambda}$: spectral radiance ($W \cdot m^{-2} \cdot sr^{-1} \cdot nm^{-1}$)

$V(\lambda)_{(a)}$: age-related spectral luminous efficiency

$\Delta\lambda$: wavelength width (5 nm)

Remarks : $L_{(a)}$ is expressed, for example, as $L_{(20)}$ if subscript (a) (increased or decreased by 10 according to the target's age) is to indicate that the target is in his/her twenties. $L_{e,\lambda}$ shall be the value measured in the range of 400 nm to 700 nm in accordance with the method specified in **JIS Z 8724**. $\Delta\lambda$ indicates wavelength width, and it should be 5 nm.

$V(\lambda)_{(a)}$ is expressed, for example, as $V(\lambda)_{(20)}$ if subscript (a) (increased or decreased by 10 according to the target's age) is to indicate that the target is in his/her twenties, and reads a suitable value from the age-related spectral luminous efficiency given in Attached Table 1 corresponding to the age of the target.

Information : When the right side of the formula (1) is multiplied by the maximum luminous efficacy, the formula (1) becomes the same formula as the formula which defines luminance, and the value corresponding to luminance is obtained. However, the maximum luminous efficacy in this case is determined by scaling so that the value at 540 THz in frequency (wavelength of about 555 nm in air) becomes 683 lm/W for the age-related spectral luminous efficiency, and differs from 683 lm/W which is determined by the same method for the spectral luminous efficiency for the CIE standard photometric observer in photopic vision.

5 Assessment of light using age-related relative luminance The assessment of light using age-related relative luminance shall be performed according to the relative relation (size relation) between values calculated using the age-related spectral luminous efficiency of the same age, and the visual response or the visual effect of two lights shall be assessed as follows:

If $L_{(a)}(A) > L_{(a)}(B)$, then the visual response or the visual effect of light A is higher than that of light B.

If $L_{(a)}(A) = L_{(a)}(B)$, then the visual response or the visual effect of light A is equal to that of light B.

If $L_{(a)}(A) < L_{(a)}(B)$, then the visual response or the visual effect of light A is lower than that of light B.

where, $L_{(a)}(A)$: age-related relative luminance ($W \cdot m^{-2} \cdot sr^{-1}$) of a years old for light A

$L_{(a)}(B)$: age-related relative luminance ($W \cdot m^{-2} \cdot sr^{-1}$) of a years old for light B

a years old : It shall be the same age for light A and light B.

6 Record When calculating and assessing the age-related relative luminance, it is desirable to record the following items as appropriate.

a) **Age of the target**

Example: 65 years old

b) **Illuminance of observation environment**

Example: 200 lx

c) **Spectral radiance**

Example:

Wavelength λ (nm)	Light A ($W \cdot m^{-2} \cdot sr^{-1} \cdot nm^{-1}$)	Light B ($W \cdot m^{-2} \cdot sr^{-1} \cdot nm^{-1}$)
400	3.121×10^{-3}	7.082×10^{-6}
405	4.176×10^{-3}	7.765×10^{-6}
410	5.753×10^{-3}	1.033×10^{-5}
⋮	⋮	⋮
695	4.055×10^{-5}	1.179×10^{-5}
700	8.054×10^{-5}	1.499×10^{-5}

d) **Type of spectral radiance meter and wavelength width** $\Delta\lambda$ (when measuring spectral radiance)

Example : ○○ spectral radiance meter, $\Delta\lambda = 5$ nm

e) **Age-related spectral luminous efficiency** (obtain from Attached Table 1 and write down)

Example : Age-related spectral luminous efficiency of sixties

Wavelength λ (nm)	$V(\lambda)_{(60)}$
400	0.001 52
405	0.002 47
410	0.003 84
⋮	⋮
695	0.009 37
700	0.006 70

f) **Calculation result of age-related luminance and assessment**

Example : $L_{(a)}(A) = 0.098\ 8\ W \cdot m^{-2} \cdot sr^{-1} > L_{(a)}(B) = 0.070\ 9\ W \cdot m^{-2} \cdot sr^{-1}$

Therefore, for the target of sixties, the visual response or the visual effect of light A is higher than that of light B.

Attached Table 1 Age-related spectral luminous efficiency

Wavelength λ	Age-related spectral luminous efficiency						
(nm)	$V(\lambda)_{(10)}$	$V(\lambda)_{(20)}$	$V(\lambda)_{(30)}$	$V(\lambda)_{(40)}$	$V(\lambda)_{(50)}$	$V(\lambda)_{(60)}$	$V(\lambda)_{(70)}$
400	0.015 12	0.009 55	0.006 03	0.003 80	0.002 40	0.001 52	0.000 96
405	0.021 59	0.014 00	0.009 08	0.005 88	0.003 82	0.002 47	0.001 60
410	0.029 43	0.019 59	0.013 03	0.008 67	0.005 77	0.003 84	0.002 56
415	0.038 33	0.026 16	0.017 85	0.012 18	0.008 31	0.005 67	0.003 87
420	0.047 67	0.033 33	0.023 31	0.016 30	0.011 40	0.007 97	0.005 57
425	0.056 62	0.040 54	0.029 02	0.020 78	0.014 88	0.010 65	0.007 63
430	0.064 23	0.047 05	0.034 46	0.025 24	0.018 49	0.013 54	0.009 92
435	0.070 56	0.052 83	0.039 56	0.029 62	0.022 18	0.016 61	0.012 43
440	0.076 09	0.058 19	0.044 51	0.034 04	0.026 03	0.019 91	0.015 23
445	0.080 55	0.062 87	0.049 08	0.038 31	0.029 90	0.023 34	0.018 22
450	0.084 91	0.067 59	0.053 81	0.042 83	0.034 10	0.027 14	0.021 61
455	0.090 40	0.073 33	0.059 48	0.048 25	0.039 14	0.031 75	0.025 75
460	0.097 20	0.080 28	0.066 30	0.054 76	0.045 23	0.037 35	0.030 85
465	0.105 55	0.088 69	0.074 52	0.062 62	0.052 62	0.044 21	0.037 15
470	0.115 84	0.098 95	0.084 52	0.072 20	0.061 67	0.052 68	0.045 00
475	0.128 59	0.111 57	0.096 81	0.084 00	0.072 88	0.063 23	0.054 86
480	0.144 38	0.127 14	0.111 97	0.098 60	0.086 83	0.076 46	0.067 34
485	0.163 96	0.146 43	0.130 77	0.116 79	0.104 30	0.093 15	0.083 19
490	0.191 03	0.172 88	0.156 45	0.141 59	0.128 14	0.115 96	0.104 94
495	0.231 64	0.212 25	0.194 49	0.178 22	0.163 31	0.149 64	0.137 12
500	0.292 32	0.271 00	0.251 24	0.232 91	0.215 93	0.200 18	0.185 58
505	0.383 92	0.359 81	0.337 22	0.316 04	0.296 19	0.277 59	0.260 16
510	0.501 09	0.474 38	0.449 08	0.425 14	0.402 47	0.381 01	0.360 69
515	0.620 60	0.592 98	0.566 59	0.541 38	0.517 29	0.494 26	0.472 27
520	0.729 34	0.702 81	0.677 25	0.652 61	0.628 88	0.606 01	0.583 96
525	0.813 32	0.789 78	0.766 92	0.744 73	0.723 17	0.702 24	0.681 92
530	0.876 33	0.856 85	0.837 80	0.819 17	0.800 95	0.783 15	0.765 73
535	0.928 98	0.913 87	0.899 00	0.884 38	0.870 00	0.855 85	0.841 93
540	0.968 87	0.958 17	0.947 59	0.937 12	0.926 78	0.916 54	0.906 42
545	0.994 15	0.987 61	0.981 10	0.974 64	0.968 22	0.961 85	0.955 51
550	1.003 62	1.000 71	0.997 80	0.994 91	0.992 02	0.989 14	0.986 27
555	1.000 00	1.000 00	1.000 00	1.000 00	1.000 00	1.000 00	1.000 00
560	0.986 59	0.988 67	0.990 76	0.992 85	0.994 95	0.997 05	0.999 16
565	0.963 78	0.967 08	0.970 40	0.973 73	0.977 07	0.980 42	0.983 79
570	0.932 23	0.935 91	0.939 61	0.943 32	0.947 05	0.950 79	0.954 55
575	0.892 26	0.895 65	0.899 06	0.902 48	0.905 92	0.909 36	0.912 82
580	0.820 24	0.828 31	0.836 45	0.844 67	0.852 97	0.861 35	0.869 82
585	0.750 62	0.762 38	0.774 32	0.786 46	0.798 78	0.811 30	0.824 01
590	0.683 77	0.698 35	0.713 25	0.728 45	0.743 99	0.759 85	0.776 05
595	0.620 05	0.636 66	0.653 72	0.671 23	0.689 21	0.707 67	0.726 63
600	0.559 71	0.577 66	0.596 18	0.615 29	0.635 01	0.655 37	0.676 38
605	0.500 13	0.518 71	0.537 97	0.557 94	0.578 66	0.600 15	0.622 44
610	0.439 90	0.458 38	0.477 64	0.497 70	0.518 61	0.540 39	0.563 09
615	0.380 86	0.398 64	0.417 25	0.436 73	0.457 12	0.478 45	0.500 79
620	0.324 59	0.341 19	0.358 64	0.376 98	0.396 26	0.416 53	0.437 84
625	0.272 29	0.287 38	0.303 30	0.320 11	0.337 84	0.356 56	0.376 32
630	0.224 85	0.238 22	0.252 38	0.267 38	0.283 28	0.300 12	0.317 97
635	0.182 77	0.194 33	0.206 63	0.219 71	0.233 61	0.248 40	0.264 12
640	0.146 23	0.156 02	0.166 45	0.177 59	0.189 47	0.202 15	0.215 67
645	0.115 17	0.123 27	0.131 93	0.141 21	0.151 13	0.161 76	0.173 13
650	0.089 28	0.095 85	0.102 89	0.110 45	0.118 56	0.127 28	0.136 63
655	0.068 39	0.073 62	0.079 25	0.085 31	0.091 83	0.098 85	0.106 40
660	0.051 96	0.056 08	0.060 52	0.065 31	0.070 48	0.076 06	0.082 08
665	0.039 16	0.042 36	0.045 82	0.049 56	0.053 61	0.057 98	0.062 72
670	0.029 27	0.031 73	0.034 39	0.037 28	0.040 41	0.043 80	0.047 47
675	0.021 70	0.023 56	0.025 59	0.027 79	0.030 18	0.032 78	0.035 60
680	0.015 95	0.017 36	0.018 88	0.020 54	0.022 34	0.024 30	0.026 44
685	0.011 64	0.012 68	0.013 81	0.015 04	0.016 39	0.017 85	0.019 45
690	0.008 42	0.009 18	0.010 01	0.010 92	0.011 91	0.012 99	0.014 17
695	0.006 04	0.006 59	0.007 20	0.007 86	0.008 58	0.009 37	0.010 23
700	0.004 30	0.004 70	0.005 13	0.005 61	0.006 13	0.006 70	0.007 32

Annex 1 (informative)

Example of calculation of visual contrast using age-related relative luminance

This Annex (informative) describes the complementary matter related to the text, and does not constitute provisions of this Standard.

1 Scope This Annex describes the example of calculation of the visual contrast using the age-related relative luminance. However, this example of calculation is not applied to Annex 2 (informative).

2 Definitions For the purposes of this Annex, in addition to the definitions in clause **3** of the text and **JIS Z 8113**, the following definitions shall apply.

a) **transition rule** For the age-related relative luminance A and B, if $A = B$ and $B = C$, then $A = C$ holds.

b) **proportionality rule** For the age-related relative luminance A and B, if $A = B$, then $kA = kC$ holds;

where, k is constant.

c) **additivity rule** For the age-related relative luminance A, B, C and D, if $A = B$ and $C = D$, then $A + C = B + D$ holds.

d) **visual contrast** Contrast of colour or brightness of two lights expressed based on visual sensations.

3 General principle of age-related relative luminance As long as the age-related relative luminance is calculated using the age-related spectral luminous efficiency of the same age, transition rule, proportionality rule and additivity rule hold. Furthermore, the ratio of the age-related relative luminance calculated using the age-related spectral luminous efficiency of the same age is, for example, capable of expressing the quantitative relation such as the visual contrast of light and darkness. However, since the age-related relative luminance expresses the value of relative luminance defined independently for every age based on the age-related spectral luminous efficiency of each age, the value of relative luminance of the same age can be compared, but the value of relative luminance of the different ages cannot be compared and therefore, for the same reason, any of transition rule, proportionality rule and additivity rule do not hold.

4 Example of calculation of visual contrast The age-related relative luminance of each observer of twenties and sixties is calculated for the background and sign of visual signs and displays shown in Annex 1 Fig. 1, and based on this the visual contrast is calculated according to the following formula.

a) **Calculation of visual contrast of twenties** The age-related relative luminance for spectral radiance of sign and background shown in Annex 1 Fig. 1 is obtained according to the formula (1) of clause 4 of the text using the age-related spectral luminous efficiency $V(\lambda)_{(20)}$ of twenties, and from the value the visual contrast is calculated and the following result is obtained.

$$L_{(20)}(s) = \sum_{400}^{700} L_{e,\lambda} V(\lambda)_{(20)} \Delta\lambda = 0.238 \text{ W} \cdot \text{m}^{-2} \cdot \text{sr}^{-1}$$

$$L_{(20)}(b) = \sum_{400}^{700} L_{e,\lambda} V(\lambda)_{(20)} \Delta\lambda = 0.158 \text{ W} \cdot \text{m}^{-2} \cdot \text{sr}^{-1}$$

$$C_{(20)} = \frac{L_{(20)}(s) - L_{(20)}(b)}{L_{(20)}(b)} = 0.51$$

where, $L_{(20)}(s)$: age-related relative luminance of twenties of sign ($\text{W} \cdot \text{m}^{-2} \cdot \text{sr}^{-1}$)

$L_{(20)}(b)$: age-related relative luminance of twenties of background ($\text{W} \cdot \text{m}^{-2} \cdot \text{sr}^{-1}$)

$C_{(20)}$: visual contrast of observer of twenties

b) **Calculation of visual contrast of sixties** The same calculation as **a**) is performed using the age-related spectral luminous efficiency $V(\lambda)_{(60)}$ of sixties, and the following result is obtained.

$$L_{(60)}(s) = \sum_{400}^{700} L_{e,\lambda} V(\lambda)_{(60)} \Delta\lambda = 0.193 \text{ W} \cdot \text{m}^{-2} \cdot \text{sr}^{-1}$$

$$L_{(60)}(b) = \sum_{400}^{700} L_{e,\lambda} V(\lambda)_{(60)} \Delta\lambda = 0.163 \text{ W} \cdot \text{m}^{-2} \cdot \text{sr}^{-1}$$

$$C_{(60)} = \frac{L_{(60)}(s) - L_{(60)}(b)}{L_{(60)}(b)} = 0.18$$

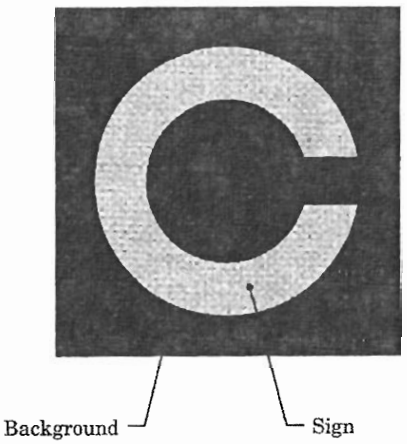
where, $L_{(60)}(s)$: age-related relative luminance of sixties of sign ($\text{W} \cdot \text{m}^{-2} \cdot \text{sr}^{-1}$)

$L_{(60)}(b)$: age-related relative luminance of sixties of background ($\text{W} \cdot \text{m}^{-2} \cdot \text{sr}^{-1}$)

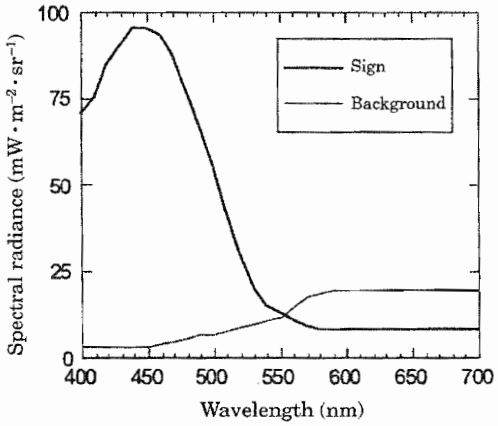
$C_{(60)}$: visual contrast of observer of sixties

c) **Assessment** The visual contrast of sign shown in Annex 1 Fig. 1 is 0.51 for the young of twenties, and 0.18 for the elderly of sixties from the result in **a**) and **b**), and it is assessed that the visual contrast of the elderly is lowered by a large amount compared with that of the observer of twenties.

Remarks : The age-related relative luminance of sign of twenties [$L_{(20)}(s)$ = 0.238 $\text{W} \cdot \text{m}^{-2} \cdot \text{sr}^{-1}$] and the same luminance of sixties [$L_{(60)}(s)$ = 0.163 $\text{W} \cdot \text{m}^{-2} \cdot \text{sr}^{-1}$] cannot be directly compared. Similarly, the age-related relative luminance of background cannot be compared between the two different ages.



a) **Example of visual signs and displays**



b) **Spectral radiance of sign and background**

Annex 1 Fig. 1 Example of visual signs and displays used for example of calculation of age-related relative luminance and its spectral radiance

Annex 2 (informative)

Specification of age-related relative equivalent luminance and its use in assessment of light

Introduction The equivalent luminance for assessing brightness based on the difference between luminance and brightness has been defined by International Commission on Illumination (CIE), and the possibility of its introduction to the photometric system is now being studied. This Annex (informative), on the basis of these moves, describes the specification of age-related relative luminance and its use in assessment of light in consideration of the change of equivalent luminance with age.

In addition, this Annex (informative) describes the complementary matter related to the text, and does not constitute provisions of this Standard.

1 Scope This Annex describes the method of assessment of the visual efficiency of light and the visibility based on it when the target of various ages look at the light source and the object using the age-related relative equivalent luminance in consideration of ages of the target. The age-related relative equivalent luminance is applied when the visual efficiency of light is assessed based on the brightness of the light source and the object. Furthermore, the age-related relative equivalent luminance is now applied only to monochromatic light.

2 Definitions For the purposes of this Annex, in addition to the definitions in clause **3** of the text and **JIS Z 8113**, the following definitions shall apply.

a) **equivalent luminance** Luminance of reference light which has the same brightness as that of the light source and the object to be targeted using monochromatic light of 540 THz in frequency as reference light.

b) **brightness spectral luminous efficiency** Spectral luminous efficiency which is considered to express the brightness of the light source and the object, which is obtained by the visual photometry which assesses the brightness by looking at fixed light directly.

c) **age-related brightness spectral luminous efficiency** Brightness spectral luminous efficiency determined by age in consideration of the change of brightness spectral luminous efficiency with age.

d) **age-related relative equivalent luminance** Quantity which is corresponding to equivalent luminance, which is calculated by age based on the age-related brightness spectral luminous efficiency.

e) **additivity rule** For the age-related relative equivalent luminance A, B, C and D, if $A = B$ and $C = D$, then $A + C = B + D$ holds.

3 General principle of age-related relative equivalent luminance For the age-related relative equivalent luminance, additivity rule does not hold. That is, for the age-related relative equivalent luminance A, B, C and D, if $A = B$ and $C = D$, then $A + C = B + D$ does not always hold.

4 Specification of age-related relative equivalent luminance The age-related relative equivalent luminance shall be calculated only for monochromatic radiation according to the following formula (1).

$$L_{eq,(a)} = L_{e,\lambda} V_b(\lambda)_{(a)} \Delta\lambda \quad \cdots\cdots (1)$$

where, $L_{eq,(a)}$: age-related relative equivalent luminance ($W \cdot m^{-2} \cdot sr^{-1}$)

$L_{e,\lambda}$: spectral radiance ($W \cdot m^{-2} \cdot sr^{-1} \cdot nm^{-1}$)

$V_b(\lambda)_{(a)}$: age-related brightness spectral luminous efficiency

$\Delta\lambda$: wavelength width (5 nm)

Remarks : $L_{eq,(a)}$ is expressed, for example, as $L_{eq,(20)}$ if subscript (a) (increased or decreased by 10 according to the target's age) is to indicate that the target is in his/her twenties. $L_{e,\lambda}$ shall be the value measured in the range of 400 nm to 700 nm in accordance with the method specified in **JIS Z 8724**. $\Delta\lambda$ indicates wavelength width, and it should be 5 nm. $V_b(\lambda)_{(a)}$ is expressed, for example, as $V_b(\lambda)_{(20)}$ if subscript (a) (increased or decreased by 10 according to the target's age) is to indicate that the target is in his/her twenties, and reads a suitable value from the age-related brightness spectral luminous efficiency given in Annex 2 Attached Table 1 corresponding to the age of the target.

Information : When the right side of the formula (1) is multiplied by the maximum luminous efficacy, the formula (1) becomes the same formula as the formula which defines equivalent luminance, and the value corresponding to equivalent luminance is obtained. However, the maximum luminous efficacy in this case is determined by scaling so that the value at 540 THz in frequency (wavelength of about 555 nm in air) becomes 683 lm/W for the age-related brightness spectral luminous efficiency, and differs from 683 lm/W which is determined by the same method for the spectral luminous efficiency for the CIE standard photometric observer in photopic vision.

5 Assessment of light using age-related relative equivalent luminance The assessment of light using the age-related relative equivalent luminance shall be performed according to the relative relation (size relation) between values calculated using the age-related spectral luminous efficiency, and the brightness of two lights shall be assessed as follows:

If $L_{eq,(a)}(A) > L_{eq,(a)}(B)$, then light A is brighter than light B.

If $L_{eq,(a)}(A) = L_{eq,(a)}(B)$, then light A is equal to light B in brightness.

If $L_{eq,(a)}(A) < L_{eq,(a)}(B)$, then light A is darker than light B.

where, $L_{eq,(a)}(A)$: age-related relative equivalent luminance ($W \cdot m^{-2} \cdot sr^{-1}$) of a years old for light A

$L_{eq,(a)}(B)$: age-related relative equivalent luminance ($W \cdot m^{-2} \cdot sr^{-1}$) of a years old for light B

Remarks : For the assessment of light using the age-related relative equivalent luminance, the values of the age-related relative equivalent luminance

calculated using the age-related brightness spectral luminous efficiency of the different ages cannot be compared, or the age-related relative equivalent luminance cannot be compared with the value of luminance using spectral luminous efficiency for the CIE standard photometric observer.

6 Record When calculating and assessing the age-related relative equivalent luminance, it is desirable to record the following items as appropriate.

a) **Age of the target**

Example: 65 years old

b) **Illuminance of observation environment**

Example: 200 lx

c) **Spectral radiance**

Example: light A $\lambda = 470$ nm 0.105 $W \cdot m^{-2} \cdot sr^{-1} \cdot nm^{-1}$

Example: light B $\lambda = 635$ nm 0.010 5 $W \cdot m^{-2} \cdot sr^{-1} \cdot nm^{-1}$

d) **Type of spectral radiance meter and wavelength width** $\Delta\lambda$ (when measuring spectral radiance)

Example: ○○ spectral radiance meter, $\Delta\lambda = 5$ nm

e) **Age-related brightness spectral luminous efficiency** (obtain from Annex 2 Attached Table 1 and write down)

Example: Age-related brightness spectral luminous efficiency of sixties

$\lambda = 470$ nm 0.060 68

$\lambda = 635$ nm 0.243 48

f) **Calculation result of age-related equivalent luminance and assessment**

Example: $L_{eq,(a)}(A) = 0.031\ 9\ W \cdot m^{-2} \cdot sr^{-1} > L_{eq,(a)}(B) = 0.012\ 8\ W \cdot m^{-2} \cdot sr^{-1}$

Therefore, for the target of sixties, light A is brighter than light B.

Annex 2 Attached Table 1 Age-related brightness spectral luminous efficiency

Wavelength λ	Age-related spectral luminous efficiency						
(nm)	$V(\lambda)_{(10)}$	$V(\lambda)_{(20)}$	$V(\lambda)_{(30)}$	$V(\lambda)_{(40)}$	$V(\lambda)_{(50)}$	$V(\lambda)_{(60)}$	$V(\lambda)_{(70)}$
400	0.020 86	0.013 48	0.008 71	0.005 63	0.003 64	0.002 35	0.001 52
405	0.033 70	0.022 13	0.014 53	0.009 54	0.006 27	0.004 11	0.002 70
410	0.044 71	0.029 82	0.019 89	0.013 27	0.008 85	0.005 90	0.003 94
415	0.051 52	0.034 90	0.023 65	0.016 02	0.010 86	0.007 35	0.004 98
420	0.059 87	0.041 20	0.028 35	0.019 51	0.013 42	0.009 24	0.006 36
425	0.070 18	0.049 04	0.034 27	0.023 95	0.016 73	0.011 69	0.008 17
430	0.081 48	0.057 81	0.041 02	0.029 10	0.020 65	0.014 65	0.010 40
435	0.092 00	0.066 27	0.047 74	0.034 39	0.024 77	0.017 84	0.012 85
440	0.101 03	0.073 88	0.054 02	0.039 51	0.028 89	0.021 13	0.015 45
445	0.107 91	0.080 09	0.059 45	0.044 12	0.032 75	0.024 31	0.018 04
450	0.115 06	0.086 68	0.065 29	0.049 18	0.037 05	0.027 91	0.021 02
455	0.125 74	0.096 12	0.073 47	0.056 17	0.042 94	0.032 82	0.025 09
460	0.140 81	0.109 22	0.084 72	0.065 71	0.050 97	0.039 53	0.030 66
465	0.161 61	0.127 17	0.100 08	0.078 75	0.061 97	0.048 77	0.038 38
470	0.187 20	0.149 44	0.119 29	0.095 22	0.076 01	0.060 68	0.048 44
475	0.215 52	0.174 50	0.141 29	0.114 40	0.092 63	0.075 00	0.060 73
480	0.246 62	0.202 52	0.166 30	0.136 56	0.112 14	0.092 08	0.075 62
485	0.280 50	0.233 57	0.194 50	0.161 96	0.134 87	0.112 30	0.093 52
490	0.323 60	0.273 22	0.230 68	0.194 77	0.164 45	0.138 85	0.117 23
495	0.386 43	0.330 78	0.283 15	0.242 37	0.207 46	0.177 59	0.152 01
500	0.477 69	0.414 50	0.359 67	0.312 09	0.270 80	0.234 98	0.203 90
505	0.611 25	0.537 59	0.472 81	0.415 84	0.365 73	0.321 66	0.282 90
510	0.773 59	0.689 54	0.614 61	0.547 83	0.488 30	0.435 24	0.387 95
515	0.925 26	0.835 72	0.754 85	0.681 81	0.615 83	0.556 24	0.502 41
520	1.045 84	0.957 13	0.875 94	0.801 64	0.733 64	0.671 41	0.614 46
525	1.117 18	1.035 81	0.960 37	0.890 42	0.825 57	0.765 44	0.709 69
530	1.149 26	1.079 39	1.013 77	0.952 13	0.894 25	0.839 88	0.788 82
535	1.160 23	1.103 71	1.049 94	0.998 79	0.950 14	0.903 85	0.859 82
540	1.149 47	1.107 41	1.066 89	1.027 84	0.990 23	0.954 00	0.919 09
545	1.117 59	1.090 28	1.063 64	1.037 66	1.012 31	0.987 57	0.963 45
550	1.066 33	1.053 29	1.040 40	1.027 67	1.015 10	1.002 69	0.990 42
555	1.000 00	1.000 00	1.000 00	1.000 00	1.000 00	1.000 00	1.000 00
560	0.923 15	0.934 48	0.945 94	0.957 54	0.969 28	0.981 17	0.993 20
565	0.838 90	0.859 51	0.880 62	0.902 24	0.924 40	0.947 10	0.970 36
570	0.750 75	0.778 38	0.807 02	0.836 71	0.867 50	0.899 41	0.932 51
575	0.786 82	0.797 29	0.807 90	0.818 65	0.829 55	0.840 59	0.851 77
580	0.799 05	0.795 18	0.791 33	0.787 50	0.783 69	0.779 89	0.776 12
585	0.808 09	0.790 72	0.773 72	0.757 10	0.740 82	0.724 90	0.709 32
590	0.813 83	0.783 95	0.755 17	0.727 45	0.700 74	0.675 02	0.650 24
595	0.816 19	0.774 93	0.735 75	0.698 56	0.663 24	0.629 71	0.597 87
600	0.815 16	0.763 74	0.715 56	0.670 43	0.628 14	0.588 51	0.551 39
605	0.803 16	0.743 46	0.688 20	0.637 05	0.589 70	0.545 87	0.505 30
610	0.773 38	0.708 15	0.648 42	0.593 73	0.543 66	0.497 80	0.455 82
615	0.727 81	0.660 01	0.598 52	0.542 76	0.492 19	0.446 34	0.404 75
620	0.669 39	0.601 90	0.541 22	0.486 65	0.437 58	0.393 47	0.353 79
625	0.601 69	0.537 10	0.479 45	0.427 98	0.382 04	0.341 03	0.304 42
630	0.528 57	0.468 97	0.416 09	0.369 17	0.327 54	0.290 61	0.257 84
635	0.453 80	0.400 67	0.353 76	0.312 34	0.275 77	0.243 48	0.214 97
640	0.380 77	0.334 95	0.294 65	0.259 19	0.228 00	0.200 57	0.176 43
645	0.312 25	0.273 99	0.240 42	0.210 97	0.185 12	0.162 44	0.142 54
650	0.250 24	0.219 30	0.192 19	0.168 42	0.147 60	0.129 35	0.113 35
655	0.196 47	0.172 16	0.150 86	0.132 20	0.115 84	0.101 51	0.088 95
660	0.151 48	0.132 88	0.116 57	0.102 26	0.089 71	0.078 70	0.069 04
665	0.114 69	0.100 84	0.088 67	0.077 96	0.068 55	0.060 28	0.053 00
670	0.085 27	0.075 24	0.066 39	0.058 58	0.051 69	0.045 61	0.040 24
675	0.062 26	0.055 19	0.048 93	0.043 38	0.038 46	0.034 09	0.030 22
680	0.044 64	0.039 81	0.035 50	0.031 66	0.028 23	0.025 18	0.022 45
685	0.031 43	0.028 23	0.025 35	0.022 77	0.020 45	0.018 37	0.016 50
690	0.021 73	0.019 68	0.017 82	0.016 14	0.014 62	0.013 24	0.011 99
695	0.014 75	0.013 49	0.012 33	0.011 27	0.010 31	0.009 42	0.008 62
700	0.009 84	0.009 09	0.008 40	0.007 76	0.007 17	0.006 63	0.006 13

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Standardization Promotion Department, Japanese Standards Association
4-1-24, Akasaka, Minato-ku, Tokyo, 107-8440 JAPAN
TEL. 03-3583-8002 FAX. 03-3583-0462